PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

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PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	28.02.2005

Applicant's or agent's file reference	IMPORTANT NOTIFICATION
TIMK 8502WO	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 03/31601	06.10.2003	11.10.2002

Applicant
THE TIMKEN COMPANY

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international preliminary examining authority:

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PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference TIMK 8502WO	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US 03/31601	International filing date *(day/month/year)* 06.10.2003	Priority date *(day/month/year)* 11.10.2002
International Patent Classification (IPC) or both national classification and IPC G01P3/80		
Applicant THE TIMKEN COMPANY		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
04.05.2004	28.02.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Reto, D Telephone No. +31 70 340-4941

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US 03/31601

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1-10 as originally filed

Claims, Numbers

1-19 received on 30.07.2004 with letter of 30.07.2004

Drawings, Sheets

1/3-3/3 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☒ the claims, Nos.: 20,21
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-19
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-19
Industrial applicability (IA)	Yes:	Claims	1-19
	No:	Claims	

2. Citations and explanations

   see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1: WO 85/05187 A (STIFTELSEN INST MIKROVAGS) 21 November 1985 (1985-11-21)

D2: PATENT ABSTRACTS OF JAPAN vol. 018, no. 253 (P-1737), 13 May 1994 (1994-05-13) -& JP 06 034647 A (HAMAMATSU PHOTONICS KK), 10 February 1994 (1994-02-10)

2 INDEPENDENT CLAIM 1

2.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of **claim 1** does not involve an inventive step in the sense of Article 33(3) PCT.

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses (the references in parentheses applying to this document) a speed sensing system with:
- a first speed sensor unit (11, 14) operatively disposed adjacent a surface (Fig.1) of a target object (2), configured to generate a first signal responsive to the passage of at least one random feature of the target object (page 2, line 17-24 and page 6, line 17-25);
- a second speed sensor unit (10, 13) operatively disposed adjacent a surface of the target object (2) and displaced at a predetermined distance from the first speed sensor unit in a direction of motion of the target object (Fig.1), the second speed sensor unit configured to generate a second signal responsive to the passage of said at least one random feature of said target object (page 2, line 17-24 and page 6, line 17-page 7, line 17);
- and a signal processor (5) configured to receive first and second signals, further configured to apply a cross correlation analysis to determine a phase shift between

said first and second generated signals, said phase shift inversely proportional to a speed of said target object (page 3, lines 8-14, page 5, lines 29-36).

2.2 The subject-matter of claim 1 therefore differs from this known speed measuring system in that the cross correlation analysis is based on a Fast Fourier Transform algorithm.

Hence, the subject-matter of independent claim 1 is novel in view of D1 (Article 33(2) PCT).

2.3 The problem to be solved by the present invention may therefore be regarded as to provide fast processing means for the cross correlation calculations.

Different algorithms can be used for cross correlation calculations, the Fast Fourier Transform algorithm being one of the most commonly used. It is also generally known that algorithms based on Fast Fourier Transform are much faster and thus take considerably less time to compute when compared with other known algorithms. Therefore, the skilled person would consider the use of a Fast Fourier Transform-based algorithm when looking for faster calculation means, without the use of an inventive skill. Therefore this claim is not inventive over D1.

3 INDEPENDENT CLAIM 14

3.1 **Claim 14** does not involve an inventive step in the sense of Article 33(3) PCT. Method claim 14 corresponds to the apparatus claim 1 and therefore the remarks made on paragraphs 2.1, 2.2 and 2.3 also hold for this claim.

3.2 The subject-matter of claim 14 further differs from the known method for speed measurement disclosed in D1 by the step of filtering direct current components from the first and second generated signals, prior to the step of Fast Fourier Transform cross correlation analysis.

Consequently, the subject-matter of independent claim 14 is novel over D1 (Article 33(2) PCT).

3.3 When using cross correlation analysis algorithms, the skilled person is only interested in time varying components of the signal since these are the ones relevant for the determination of a specific parameter, in this case speed. It is also well known that DC components can create, during the Fast Fourier Transform step, low frequency peaks that influence the algorithm output. In computational methods this is a well known problem and it is a common procedure to filter any DC components present in the signals prior to the correlation step. Therefore this feature does not have any surprising effect. Consequently, the claim does not involve an inventive step.

4 DEPENDENT CLAIMS 2-13 AND 15-19

Dependent **claims 2-13 and 15-19** do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT of inventive step, the reasons are as follows:

4.1 In **claims 2, 3 and 4**, the use of additional speed sensors in order to cancel signal components common to the sensors and providing differential signals between them, is well known and therefore not inventive, see for example D2. The same remarks hold for **claim 17**.

4.2 **Claim 5** refers to an eddy current sensor responsive to a random subsurface target feature. Eddy current sensors are commonly used for speed measurement apparatus that consequently, given the working principle of this type of sensor, are able to detect subsurface features. Same remarks apply for **claim 12**.

4.3 Optical sensors are also commonly used and therefore **claim 6** is not inventive.

4.4 The remarks of paragraphs 3.3 and 2 hold for **claims 7 and 8**, respectively.

4.5 **Claim 9** refers to a known feature and equation used for calculating the speed of a target when using cross correlation. Therefore this claim is not inventive. The same remarks hold for **claims 15 and 16**.

4.6 **Claim 10** represents a slight constructional change which has no surprising technical

effect and is therefore not inventive.

4.7 **Claim 11** refers to a random surface feature of the target object, which is already present in claim 1 and disclosed in D1.

4.8 In **claim 13**, the selection of a sampling rate greater than the signal variation is an obvious design procedure, thus not being inventive.

4.9 **Claims 18 and 19** refer to well known methods used for calculating the relative position and speed of a target object.

5 REMARKS

5.1 The features of claim 11 are already present in independent claim 1 and therefore claim 11 is redundant and not concise according to Article 6 PCT.

5.2 The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

SUBSTITUTE SHEET

Claims

1. A speed sensing system for measuring the speed of a target object, comprising:

a first speed sensor unit operatively disposed adjacent a surface of said target object, said first speed sensor unit configured to generate a first signal responsive to the passage of at least one random feature of said target object;

a second speed sensor unit operatively disposed adjacent a surface of said target object and displaced at a predetermined distance from said first speed sensor unit substantially in a direction of motion of the target object, said second speed sensor unit configured to generate a second signal responsive to the passage of said at least one random feature of said target object; and

a signal processor configured to receive said first and second signals, said signal processor further configured to apply a cross correlation analysis with a Fast Fourier Transform-based algorithm to determine a phase shift between said first and second generated signals, said phase shift inversely proportional to a speed of said target object.

2. The speed sensing system of Claim 1 further including:

a third speed sensor unit operatively disposed adjacent a surface of said target object, said third speed sensor unit configured to generate a third signal responsive to the passage of at least one feature of said target object;

a fourth speed sensor unit operatively disposed adjacent a surface of said target object and displaced at a predetermined distance from said third speed sensor unit substantially in a direction of motion of the target object, said fourth speed sensor unit configured to generate a fourth signal responsive to the passage of said at least one feature of said target object; and

wherein said signal processor is further configured to receive said third and fourth signals, and to utilize said third and fourth signals to

cancel signal components common to said first, second, third, and fourth signals.

3. The speed sensing system of Claim 2 wherein said signal processor is further configured to provide differential signals between the first and third signals, and between the second and fourth signals, and said signal processor is further configured to determine a phase shift between said third and fourth generated signals, said phase shift inversely proportional to a speed of said target object.

4. The speed sensing system of Claim 2 wherein said first and third speed sensing units define a first differential sensing pair;

wherein said second and fourth speed sensing units define a second differential sensing pair; and

wherein said first and second differential sensing pairs are spaced apart by a predetermined distance parallel to said direction of motion of the target object.

5. The speed sensing system of Claim 1 wherein said first and second speed sensing units are eddy current sensors; and

wherein said at least one feature is a random subsurface target feature.

6. The speed sensing system of Claim 1 wherein said first and second speed sensing units are optical sensors.

7. The speed sensing system of Claim 1 wherein said signal processor is configured to filter direct-current components from said first and second generated signals such that said generated signals have a zero signal mean.

8. The speed sensing system of Claim 1 wherein said signal processor is configured utilize a Fast Fourier Transform-based algorithm to determine a cross correlation function between said generated signals, said cross correlation function defined by:

$$y(\tau) = \int x_1(t+\tau) \cdot x_2(t) dt$$

where x_1 is said first generated signal;

x_2 is said second generated signal;

t is a signal time; and

τ is a time delay between said generated signals.

9. The speed sensing system of Claim 8 wherein said phase shift is associated with a maximum value for said cross correlation function; and wherein said signal processor is further configured to determine a maximum value for said cross correlation function;

wherein a speed v of said target object is determined from:

$$v = \frac{L}{\tau_0}$$

where L is said predetermined distance; and

τ_0 is a time delay corresponding to said determined maximum value for said cross correlation function.

10. The speed sensing system of Claim 1 wherein said first speed sensor unit and said second speed sensor unit are disposed within a common housing.

11. The speed sensing system of Claim 1 wherein said at least one target feature is a random surface feature of the target object.

12. The speed sensing system of Claim 1 wherein said at least one target feature is a random subsurface feature of the target object.

13. The speed sensing system of Claim 1 where each of said first and second speed sensing units has an identical sampling rate; and

wherein said identical sampling rate is substantially greater than a signal variation rate for said first and second speed sensing units.

14. A method for speed measurement of a target object, comprising the steps of:

observing at a first point, a passage of at least one random feature of the target object;

generating a first signal responsive to said passage of said at least one random feature at said first point;

observing at a second point, displaced at a predetermined distance from said first point in a direction of motion of said target object, said passage of said at least one random feature of the target object;

generating a second signal responsive to said passage of said at least one random feature at said second point;

filtering direct-current components from said first and second generates signals;

applying a cross correlation analysis with a Fast Fourier Transform-based algorithm to calculate a phase shift between said filtered first signal and said filtered second signal, said phase shift inversely proportional to a speed of said target object.

15. The method of Claim 14 for speed measurement of an object wherein said phase shift is associated with a maximum value of a cross correlation function between said filtered first and second generated signals, and wherein said step of applying further includes calculating said maximum value of said cross correlation function between said filtered first and second generated signals, said cross correlation function defined by:

$$y(\tau) = \int x_1(t+\tau) \cdot x_2(t) dt$$

where x_1 is said first generated signal;

x_2 is said second generated signal;

t is a signal time; and

τ is a time delay between said generated signals.

16. The method of Claim 15 for speed measurement of an object, further including the step of determining a speed v of said target object from:

$$v = \frac{L}{\tau_0}$$

where L is said predetermined distance;

and τ_0 is a time delay corresponding to said determined maximum value for said cross correlation function.

17. The method of Claim 14 for speed measurement of an object further including the steps of :

observing at a third point, a passage of an additional feature of the target object;

generating at least one additional signal responsive to said passage of said additional feature at said third point;

utilizing said at least one additional signal to cancel common elements present in each of said first and second generated signals.

18. A method of Claim 14 for speed measurement of a target object further including the step of:

determining a relative position of the target object from said calculated phase shift.

19. The method of Claim 18 for determining a relative position of a target object wherein said determining step includes the step of integrating a calculated speed of said the target object with respect to time.